

## University of Groningen

### Editorial

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## Editorial: Lactic acid bacteria—a continuing journey in science and application

This issue of *FEMS Microbiology Reviews* covers the 12th international symposium on Lactic Acid Bacteria (LAB12) held on 27–31 August 2017 in Egmond aan Zee, The Netherlands. This meeting highlights the scientific journey that continues to improve our understanding of this biotechnologically important group of bacteria, which is reflected in the series of reviews presented here.

The lactic acid bacteria (LAB) encompass a phylogenetically diverse group of species that play crucial roles in a variety of food and feed fermentations worldwide. Research on these bacteria spans a wide range of subjects, from highly fundamental investigations of their molecular biology and physiology to application oriented investigations that aim to improve their performance in fermentation processes. The research field has progressed considerably over the past decades, which is exemplified by the 11 FEMS-sponsored LAB symposia that have been organised since 1983. The LAB12 symposium illustrates that the scientific journey continues, and the reviews collected in this special issue highlight the main developments in the LAB research field as well as related research fields that can inspire the LAB researchers.

More than a decade ago, the LAB field joined the worldwide microbial genomics revolution and the first genomes of representative strains of LAB species were released in the public domain. The field has made impressive progress and nowadays it is quite common to compare genomes of multiple strains of a LAB species to better comprehend their lifestyle and industrial potential. Illustrative of this development is the review by Jens Walter and colleagues, presenting an integrated view of *Lactobacillus* genomics and physiology and aiming to better understand the diverse lifestyles of the members of this genus. Effective methods for genomic analysis of LAB have triggered a renaissance in the research on evolution of these bacteria, and novel approaches for comprehensive experimental evolution strategies that include microfluidic cultivation technologies to extend our insights in physiological control mechanisms in these bacteria are reviewed by Herwig Bachmann and colleagues. The holistic approach of the genomics revolution has also drastically changed our perspectives on the regulation of gene expression in LAB, and the review by Jan Kok and colleagues takes the reader on a journey through time, describing the evolution of this research field over the past decades and ending with several recently unravelled regulatory mechanisms that involve small regulatory RNA molecules. Although genetics is commonly considered to provide a stable blueprint of the functional repertoire of

a bacterial cell, it is also becoming clear that DNA methylation patterns are dynamic and can be influenced by phase-variable restriction modification systems. These novel insights in bacterial epigenetics and the potential consequences for bacterial physiology are reviewed by Marco Oggioni and colleagues.

Traditionally, there has been a strong interest in the metabolism of the LAB, particularly in the context of their important contribution to the preservation, flavour and texture of fermented food and feed products. Although the LAB thank their names to their capacity to produce lactic acid from the available carbohydrates, some fundamental understanding of their capacity to produce both enantiomers of this organic acid remained unknown. Benoit Desguin and colleagues reviewed the characterisation of the structurally novel enzyme complex involved in lactate racemisation, which represents a breakthrough in our understanding of a long-time recognised activity in LAB that remained a mystery until recently. LAB are also known to produce extracellular polysaccharides, a characteristic that is of importance for structural and rheological properties of many fermented food products. Already several decades of research have been dedicated to these important secondary metabolites, and the contribution made by Ana Rute Neves and colleagues shows how genomic insights in LAB diversity has driven renewed attention for this capacity and its importance in industrial application. Although the LAB are probably best known for their role in dairy fermentation, they play important roles in the production of wine as well, which is reviewed by Eveline Bartowsky and colleagues, where emphasis is given to one of the best known wine-associated LAB species, *Oenococcus oeni*. In this context, it is important to get inspired by related research fields and the contribution by Kevin Verstrepen and colleagues that reviews the physiology, and flavour formation in various yeast species provides inspiring insights in important characteristics of this other microbial group of biotechnological workhorses.

There is a long history of research on bacteriophages that target LAB, and this work traditionally focussed on bacterial phage resistance mechanisms to overcome problems with phages in industrial fermentations. Over the past years, important progress has been made in the understanding of the mechanisms by which phages recognise their LAB host, a subject reviewed thoroughly by Douwe van Sinderen and colleagues. Besides being troublemakers, phages may also be applied as biotechnological tools to fight pathogenic bacteria in food products or even to selectively eradicate specific microbial targets in the gastrointestinal tract microbiota. Analogously,

antimicrobial peptides produced by LAB may be employed to serve similar purposes. Colin Hill and colleagues reviewed the latest developments in harnessing the biotechnological potential of these antimicrobial strategies in the context of food safety and intestinal microbiota management.

Several LAB strains, in particular those belonging to the genus *Lactobacillus*, are marketed as human or animal health-promoting dietary ingredient. Many probiotics have been selected on basis of their potential to suppress inflammatory responses in the intestinal tract. Philippe Langella and colleagues reviewed the large spectrum of different murine models of intestinal inflammation that are often used in this field to demonstrate probiotic potential, and describe several of the remarkable protective effects observed with probiotic bacteria. Since probiotics commonly exert their effect in the intestinal tract, it is important to understand their interaction with the complex microbial ecosystem of the intestinal microbiota that increasingly is recognised to play important roles in the modulation of a variety of aspects of host physiology. Jeroen Raes and colleagues reviewed considerations that should be taken into account when studying the intestinal microbiota in population surveys, providing an important knowledge base for research in the field of microbial modulation of human and animal health, including the use of probiotics.

The collected contributions in this thematic issue of *FEMS Microbiology Reviews* provide an excellent overview of the state-of-the-art of research on LAB and related research fields. They were written by experts in the field and have gone through the standard peer-review process. They highlight fundamental

advances in genetics and physiology of the LAB, but also pay attention to their applications in fermentation products and health-promoting dietary ingredients. We expect that this issue will further stimulate research aiming at deeper fundamental understanding of LAB, and will fuel innovation and application research to expand and improve the use of LAB in food and feed fermentation as well as in human and animal health promotion. It has been a great pleasure to act as guest editors for this collection of reviews.

Guest Editors

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